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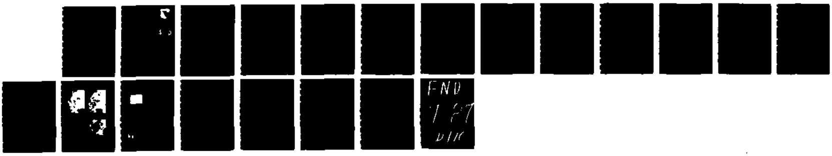

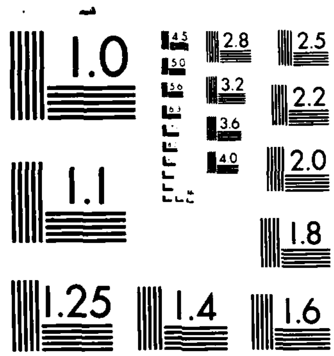
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AD-A181 080

A COMPARISON OF TRACKING PERFORMANCE DURING GY STRESS BETWEEN TEST PILOTS AND PANEL SUBJECTS

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MARCH 1987

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NOTICES

TECHNICAL REVIEW AND APPROVAL

AAMRL-TR-87-018

The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Regulation 169-3.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Henning E. von Gierke

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Director
Biodynamics and Bioengineering Division
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Seven centrifuge subjects and three AFTI/F-16 test pilots have participated in performance measuring experiments conducted on the Dynamic Environment Simulator (DES), a man-rated centrifuge. The primary task was a computer generated roll axis pursuit tracking task. The secondary task was to maintain the status quo of airspeed, altitude, pitch, and yaw. Test conditions included plus and minus 1.0, 1.25, 1.5, 1.75, and 2.0 Gy both with a standard restraint harness and with additional lateral support provided by shoulder pads. For all Gy conditions the pilots performed the primary tracking task 25% better than the subjects and the secondary task 9% better. These differences were not statistically significant. Both groups performed better when the shoulder pads (improved restraint system) were used. The standard restraint harness was rated inadequate at levels greater than 1.5 Gy.

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PREFACE AND ACKNOWLEDGEMENTS

This report documents an in-house experiment conducted on the Dynamic Environment Simulator (DES) at the Acceleration Effects Branch, Biodynamics and Bioengineering Division, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. The effort was conducted under work unit 72313501 with support from contracts F33615-81-C-0500 and F33615-83-C-0502 and jointly sponsored by the Air Force Wright Aeronautical Laboratory under a Memorandum of Agreement. The authors extend their appreciation to Diana Coddington for typing the manuscript.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

I. INTRODUCTION

Prior to the demonstration of control configured vehicle (CCV) aircraft, there had been little operational interest in lateral acceleration (Gy). The capability of CCV aircraft to perform direct side force maneuvers, however, can expose the pilot to significant Gy forces. Aircraft seats and restraint systems are designed primarily for Gz (vertical) and Gx (fore-aft) support and provide only minimal Gy (lateral) support. Test pilots who flew the YF-16 reported fatigue associated with flight modes exceeding 0.7 Gy and suggested that additional restraints may be desirable above that level (1). Inadequate restraint could also be expected to degrade performance and increase workload. Body motion induced by lateral acceleration could render a head-up display unusable and controls difficult to reach. The muscular effort required by the pilot to maintain an upright posture could adversely affect aircraft control inputs and degrade performance. A cooperative program between the Armstrong Aerospace Medical Research Laboratory (AAMRL) and the Advanced Fighter Technology Integration (AFTI)/F-16 project office of Air Force Wright Aeronautical Laboratories was undertaken to evaluate pilot performance capability during six degree of freedom flight conditions. Basically the program consisted of a series of centrifuge experiments to investigate tracking performance, control cross-coupling, restraint systems, voice controlled input devices, and physiological effects during Gy stress. Experiments have been conducted on the Dynamic Environment Simulator (DES), a man-rated three axis centrifuge at AAMRL. Both project test pilots and DES panel members have served as subjects. This report presents the results of an experiment conducted to measure tracking performance during Gy stress using the DES panel members. Comparisons are then made to the AFTI/F-16 test pilots who had previously participated in an experiment on the DES. Van Patten et al. (7,8,9) have reported on other aspects of the test pilots' performance while physiological effects have been reported by Veghte et al. (10), Popplow et al. (6), and Miller and Reader (5).

II. METHODS

Equipment

This experiment was conducted on the DES, which was programmed to produce the desired acceleration profiles by variations in arm speed and cab position. The DES cab was configured to be representative of an F-16 cockpit. The test setup included a modified Stencel aircraft seat with a 30° seat back angle, a side arm force stick, a throttle assembly, and force sensitive pre-production F-16 rudder pedals (Fig. 1). Two restraint system configurations were used. The conventional restraint consisted of a double shoulder harness (inertial reel locked) and lap belt (4.445 cm wide). The experimental restraint also included shoulder pads (10 cm x 15.2 cm) designed to provide lateral support.

Performance Task

A computer generated compensatory tracking task was displayed to the subject via a 17" cathode ray tube (CRT). The performance task display was a simulated head-up display. Information contained on the CRT included airspeed, altitude, a gunsight reticle, ground representation, and a target aircraft (Fig. 2). A sum of sines forcing function was used to drive the target aircraft in the roll axis. The subject's task was to keep the target aircraft

centered and level within the gunsight while maintaining a constant airspeed and altitude. The primary task was in roll axis tracking (to null the computer generated disturbance of the target aircraft). The scores reported are the root mean square error (erms) between the target aircraft roll angle and the subject's gunsight roll tabs. There were no computer generated disturbances to the other parameters (pitch, yaw, altitude, or airspeed). The subject's inadvertent inputs or cross-coupling into the stick, rudders, or throttle did affect these parameters and the display. The combined errors of pitch, yaw, altitude, and airspeed were given a relative value and are reported as the secondary task. Throughout all runs the subjects maintained a hands on throttle and stick posture.

Subjects and Procedures

Seven Air Force officers, experienced members of the DES panel, served as test subjects. All subjects had previous exposures to the Gy stress environments and the performance task prior to participation in the experiment. Each subject wore a standard flight suit, CSU-13B/P anti-G suit, flight boots, gloves, HGU-26/P helmet with custom poured liners, and an MBU-5/P oxygen mask. They breathed room air thru a CRU-60 connector with a defeat ring. A modified two-lead electrocardiogram, via five chest electrodes, was used to monitor heart rate and rhythm. Each DES panel subject participated in six days of testing. Days one and six were used as controls as the subjects performed 25 replications of the tracking task in the static (1Gz) environment. During test days two through five the subjects were exposed each day to twenty Gy runs. There were two sequences of ten stress environments; each consisting of plus and minus 1.0, 1.25, 1.5, 1.75, and 2.0 Gy. The Gy levels were randomized throughout each sequence while the direction, plus Gy (eyeballs left) or minus Gy (eyeballs right), was alternated. Each Gy exposure and tracking task was of 30 sec duration followed by a 30 sec rest at the baseline level (+1.4 Gz). The subjects also performed five replications of the tracking task at 1Gz and baseline (1.4Gz) both before and after the twenty Gy exposures. The tracking at 1Gz was for practice and equipment checkout while the baseline tracking scores are used in the analysis. Only one restraint condition (harness or harness plus shoulder pads) was used during each test day. The restraint configurations were alternated each day with four subjects beginning the Gy tests with the conventional system and three subjects beginning with the pads.

Test Pilots

Three test pilots had previously participated in a test program on the DES (9). The same seat, cockpit setup, restraint systems, tracking task, and Gy stress levels were used with both groups. The test pilots, because of schedule constraints, participated in two days of tests as compared to six days for the panel subjects. Therefore, there were some differences between the number of replications and order of presentations of the stress conditions between the two groups. All other conditions were identical to those of the panel subjects.

III. RESULTS

Primary Task

The primary task was a computer generated compensatory roll axis pursuit tracking task. The subjects were presented on the CRT an aft view of a target

aircraft and during 30 sec periods scored on their ability to minimize the roll angle error between the target aircraft and their fixed gunsight roll tabs. The summary results for the subjects and pilots for the five Gy levels and two restraint conditions are presented in Table I.

TABLE I. PRIMARY TASK - MEAN ROLL AXIS TRACKING SCORES (ERMS) BY GY LEVELS

	Subjects (n=7)			Test Pilots (n=3)		
	Restraint			Restraint		
Condition	Standard	Pads	Mean	Standard	Pads	Mean
1.0 Gy	166.3	165.8	166.1	131.8	121.4	126.6
1.25	163.8	164.0	163.9	125.8	119.9	122.9
1.5	173.7	163.1	168.4	122.4	127.0	124.7
1.75	175.9	161.8	168.9	142.9	122.9	132.9
2.0	174.5	166.8	170.7	129.9	116.5	123.2
Mean	170.8	164.3	167.6	130.6	121.5	126.0
	±48.9	±48.3	±47.4	±16.9	±27.5	±20.8
Baseline & s.d.			153.3 ± 39.9			122.3 ± 16.1

means ± standard deviation (s.d.)

The mean scores by Gy direction and a comparison of tracking performance between the two lower versus the two higher Gy levels are presented in Table II. Analyses of variance (ANOVA) were performed to determine the significant differences. There were no statistically significant differences of the primary task for any conditions including Gy levels, +Gy or -Gy, and the type of restraint system. The relatively small sample size and large individual variations of the data made it difficult to find significant differences ($p \leq 0.05$).

TABLE II. MEAN ROLL AXIS TRACKING (ERMS) AT +GY, -GY, AND THE TWO LOWER AND HIGHER GY LEVELS

	Subjects (n=7)			Test Pilots (n=3)		
	Restraint			Restraint		
Condition	Standard	Pads	Mean	Standard	Pads	Mean
+Gy	173.0	161.6	167.3	133.7	123.5	128.6
-Gy	168.6	167.0	167.8	127.3	119.5	123.4
Mean	170.8	164.3	167.6	130.5	121.5	126.0
1.0 & 1.25 Gy	165.1	164.9	165.0	128.8	120.7	124.8
1.75 & 2.0 Gy	175.2	164.3	169.8	136.4	119.7	128.1

Secondary Task

The secondary task was a relative measure of how well they maintained the status quo of the airspeed, altitude, pitch, and yaw of their aircraft. The results are presented in Tables III and IV. The ANOVA determined that the use of shoulder pads significantly ($p=0.03$) improved the performance of the secondary task. The improvement was similar for both plus and minus Gy but varied greatly among the individuals. There were no other statistically significant findings.

TABLE III. SECONDARY TASK - SUMMARY OF RESULTS BY GY LEVEL

	Subjects (n=7)			Test Pilots (n=3)		
	Restraint			Restraint		
Condition	Standard	Pads	Mean	Standard	Pads	Mean
1.0 Gy	13.7	11.7	12.7	14.65	11.65	13.15
1.25	16.9	11.75	14.33	14.5	12.1	13.3
1.5	16.35	13.25	14.8	14.35	12.35	13.35
1.75	19.95	13.5	16.73	19.65	12.05	15.85
2.0	22.3	14.75	18.53	17.15	12.15	14.65
Mean	17.84	12.99	15.42	16.06	12.06	14.06
	±5.5	±3.2	±3.7	±3.3	±0.4	±1.5
Baseline & s.d.			13.3 ± 2.7			12.4 ± 1.2

erms means ± standard deviation (s.d.)

TABLE IV. SECONDARY TASK AT +GY, -GY, AND THE TWO LOWER AND HIGHER GY LEVELS

	Subjects (n=7)			Test Pilots (n=3)		
	Restraint			Restraint		
Condition	Standard	Pads	Mean	Standard	Pads	Mean
+Gy	19.82	12.5	16.16	15.84	12.6	14.22
-Gy	15.86	13.48	14.67	16.3	11.52	13.91
Mean	17.84	12.99	15.42	16.06	12.06	14.06
1.0 & 1.25 Gy	15.3	11.7	13.5	14.6	13.2	13.9
1.75 & 2.0 Gy	21.1	14.2	17.7	16.6	14.4	15.5

Heart Rate

Heart rates were derived from the electrocardiographic signals from the subjects. For this experiment, heart rate data for the test pilots was not available. There was a modest increase in heart rate as the Gy stress level increased. The corresponding heart rate for the various Gy levels was decreased when the shoulder pad restraint system was used (Table V & IV). The findings were not statistically significant.

TABLE V. MEAN SUBJECT HEART RATE DATA (n=7)

	Restraint		Difference (Std-Pads)	
Condition	Standard	Pads	BPM	Percent
1.0 Gy	78.3 bpm	72.5 bpm	5.8	7.4 %
1.25	80.2	74.4	5.8	7.2 %
1.5	84.6	76.5	8.1	9.6 %
1.75	89.2	78.7	10.5	11.8 %
2.0	92.2	83.3	8.9	9.7 %
Mean	84.9	77.1	7.8	9.2 %
+Gy	83.4	76.0	7.4	8.9 %
-Gy	86.3	78.1	8.2	9.5 %

Heart rate data in beats per minute (bpm)

TABLE VI. HEART RATE DATA FOR EACH TEST CONDITION

Gy	Restraint System	
	Standard	Pads
-2.0	93.7 bpm	84.7 bpm
-1.75	91.2	80.1
-1.5	86.2	77.9
-1.25	81.2	75.6
-1.0	79.4	72.4
+1.0	77.1	72.5
+1.25	79.1	73.2
+1.5	83.0	75.1
+1.75	87.3	77.2
+2.0	90.6	81.9
Mean	84.9	77.1

IV. DISCUSSION

Primary Task: The results from the primary task of roll axis tracking are presented in Fig. 3. The most obvious effect is the absolute differences in the mean scores between the two groups, with the pilots having lower scores (i.e., less error and better tracking performance) than the panel subjects. The performance of both groups was improved slightly when shoulder pad supports were provided. Some of the individual subjects performed this task as well as the pilots (Fig. 4). As a group, however, the pilots achieved tracking proficiency much sooner than the subjects and had less variability. For all Gy conditions the pilots performed the primary task 25% better than the subjects. The difference was not statistically significant.

Secondary Task: Both groups performed the secondary task at nearly the same level of proficiency (Fig. 5). The only statistically significant finding of the study was that the subjects performed the secondary task significantly better (p=0.03) when the shoulder pads were used. When using the standard restraint system, both the test pilots and subjects had a deterioration of performance as the Gy level increased. Both groups performed markedly better and at nearly a constant level from 1 thru 2 Gy when the pads were used. For all Gy conditions the pilots performed this task 9% better than the subjects.

Heart Rate: Higher heart rate in this experiment implies increased physiological stress. A modest increase in heart rate was noted as the Gy level increased. Lower heart rates were observed at all the Gy levels when pads were used (Fig. 6). These results were similar to those reported by others (5,6,10). Miller and Reader (5) reported a slight increase in heart rate for the test pilots at 1 Gz when the tracking task was made more demanding (i.e., greater mental workload). They noted a greater heart rate increase when the test pilots were exposed to 1 and 2 Gy on the DES and a lowering of heart rate during Gy stress as the restraint system was improved. Although there were no statistically significant findings for the heart rate data, it is relevant to note that the subjects' average heart rate was reduced by 9.2% when the pads (improved restraint system) were used.

The typical comment from both the test pilots and the panel subjects was that the standard restraint system was sufficient at 1 Gy but at levels of 1.5 Gy or greater it was inadequate. In this experiment, improving the restraint system via the use of shoulder pads improved the primary performance, secondary performance, and lowered the heart rate (Fig. 6 & 7). The magnitude of the improvements for the pilots was 7.6% for the primary task and 25% for the secondary task. The subjects' performance was improved an average of 3.4% and 27% for the primary and secondary performance tasks respectively while heart rate was reduced by 9.2%. The improvements were greater at the two higher Gy levels (Tables II and IV).

While the use of shoulder pads resulted in both improved performance and reduced heart rates at the 2 Gy level, their utility at higher Gy levels could be limited. An average restraining force of 56 Kg on the shoulder at 2 Gy has been reported (2). Tracking of the subjects was less improved during the -Gy condition, when they were bearing these forces on the right shoulder, than during +Gy. In an experiment to assess neck muscle fatigue during Gy by analyzing surface electromyogram signals, Luciani et al. (3) suggested that fatigue may occur at the +2.5 Gy level. In a later experiment, Luciani (4) reported that neck muscle strength (the ability to perform a maximum isometric contraction in the opposite direction to the Gy force) was reduced by over 50% at 3 Gy. It is our opinion that at levels above 3 Gy the standard restraint system and shoulder pads will not be adequate. Additional restraint methods, such as head support, improved torso restraint, and leg supports, will be necessary to provide a satisfactory restraint system at higher Gy levels. It is hypothesized that further improvements in the restraint system would yield further improvements in tracking performance for both groups.

V. CONCLUSIONS

As a group the test pilots performed the primary tracking task better than the subjects. Some of the individual subjects performed as well as some of the individual test pilots. There was less difference between the groups on the secondary task. During these modest Gy stress levels (i.e., 1.0 thru 2.0) there was a slight decrease in performance for both groups on the primary tracking task and a marked decrease on the secondary task. Improving the restraint system resulted in improved performance and reduced heart rate. The standard restraint system was rated inadequate at levels greater than 1.5 Gy.

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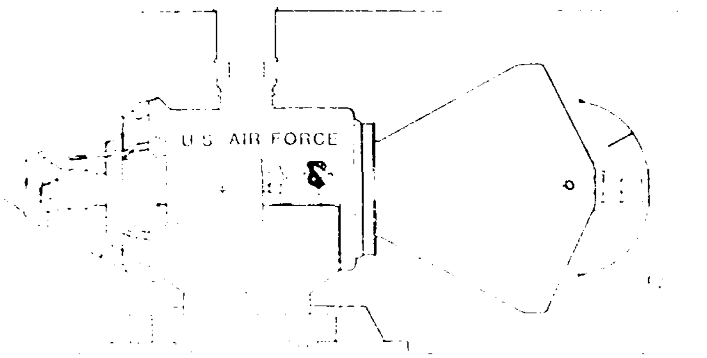
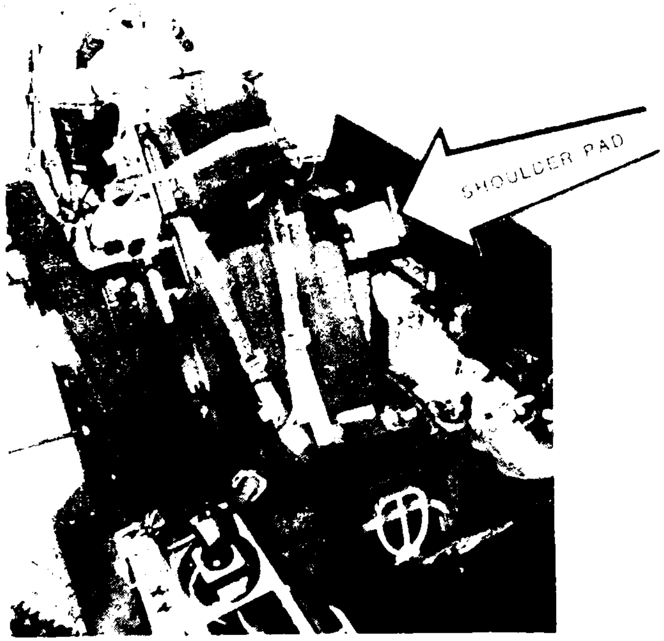
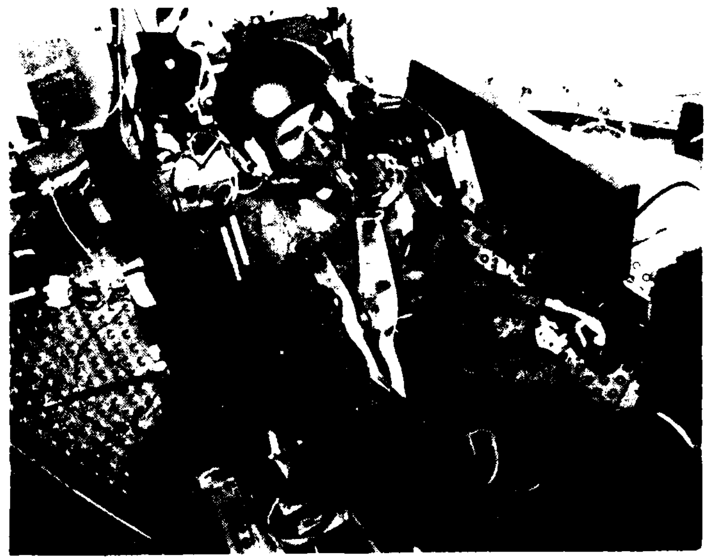


DYNAMIC ENVIRONMENT SIMULATOR (DES)

TEST PILOT AT +Gy WITH RESTRAINT SYSTEM



SEAT AND RESTRAINT SYSTEMS



SUBJECT AT -Gy WITH PADS.

Fig. 1. Photos of the DES, cab set up, and human tests.

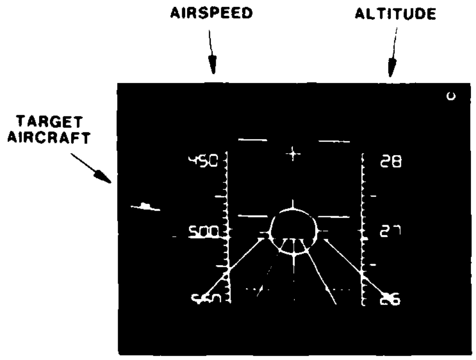


Fig. 2. Tracking display and simulated HUD.

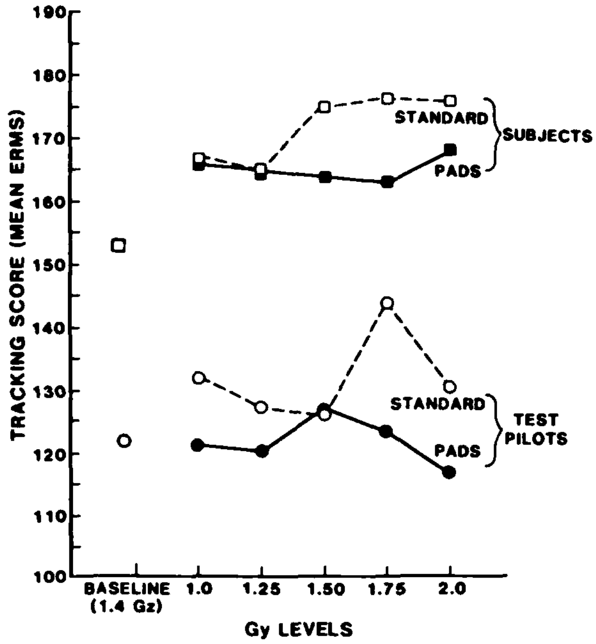


Fig. 3. Comparison of the mean roll axis tracking scores for test pilots and the DES panel subjects with the standard restraint system and the shoulder pads.

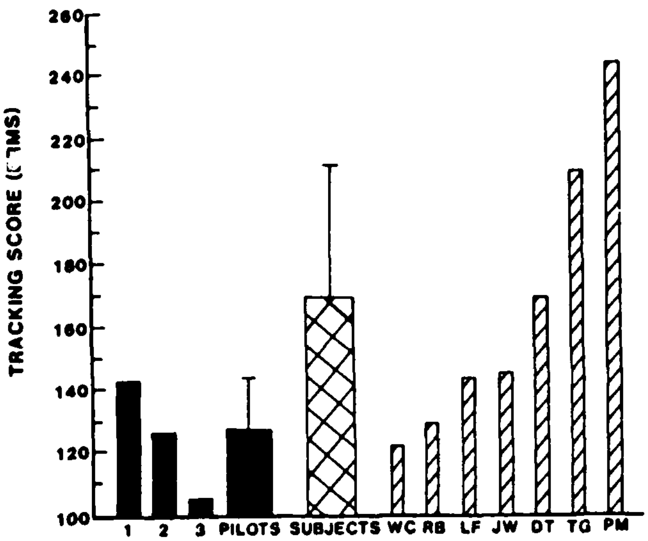


Fig.4. Mean scores of the primary tracking task for all Gy conditions for the pilots, subjects, and each individual.

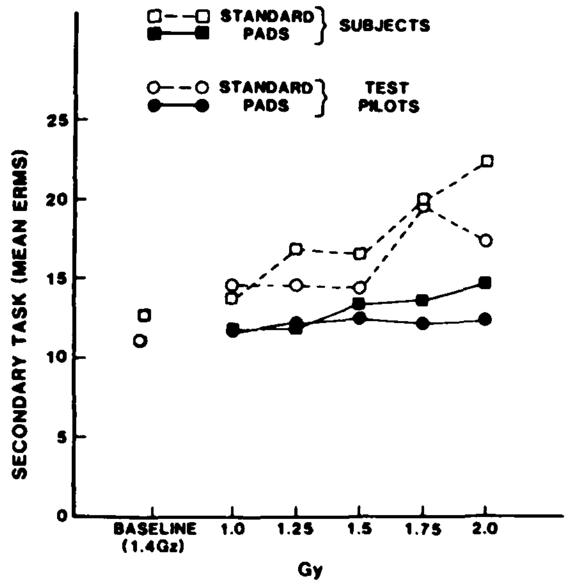


Fig. 5. Secondary task results for the test pilots and subjects.

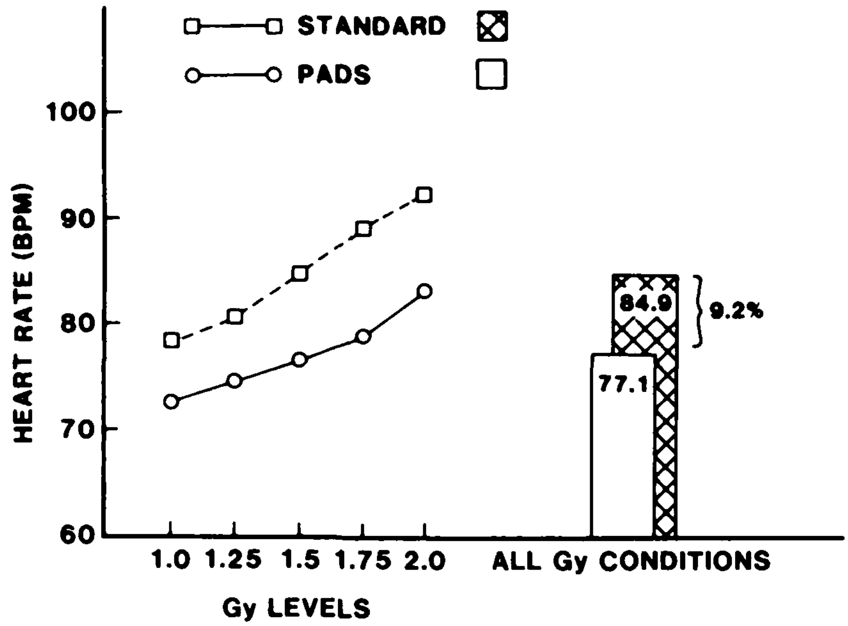


Fig. 6. Mean heart rate values for the subjects

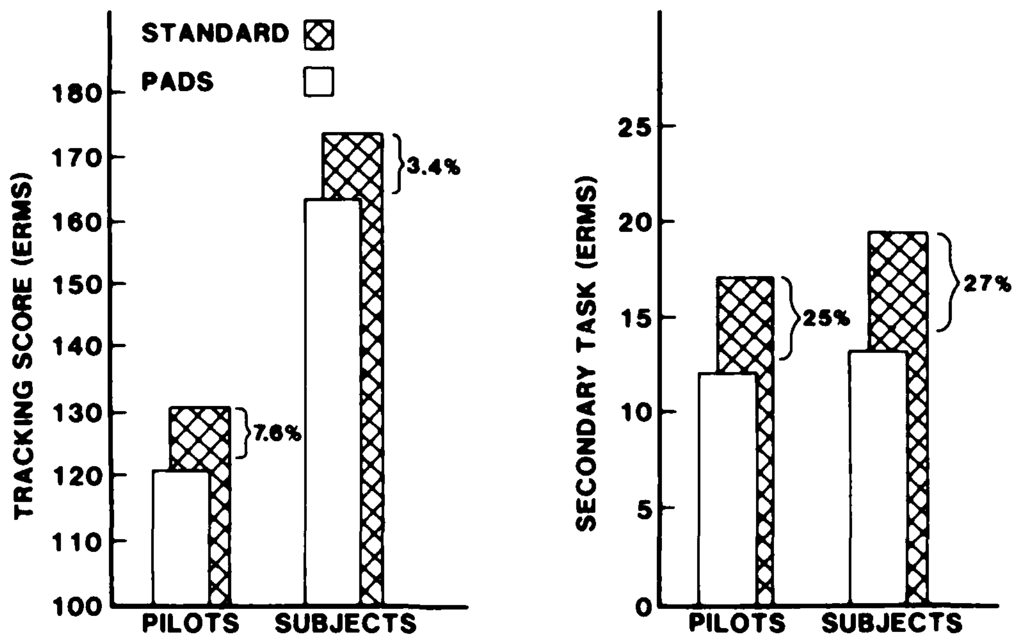


Fig. 7. Performance at all Gy stress conditions for both the pilots and subjects on the tracking and secondary performance tasks.

APPENDIX

The supplemental data is included in the appendix to more fully document this effort.

TABLE IA. SUMMARY OF INDIVIDUAL SCORES (ERMS)

	Primary Tracking Task		Secondary Task	
Subject	Baseline	All Gy Levels	Baseline	All Gy Levels
1	159.9	168.2	12.5	17.4
2	209.1	243.8	12.0	17.1
3	104.9	120.3	12.2	12.9
4	124.8	129.2	11.1	11.0
5	138.6	145.3	12.1	12.9
6	204.1	221.7	18.9	21.8
7	131.7	144.3	14.5	14.9
Mean	153.3	167.6	13.3	15.4
± s.d.	39.9	47.4	2.7	3.7
Pilot				
1	131.6	145.1	11.1	14.2
2	103.7	103.8	13.5	15.5
3	131.6	129.1	12.7	12.5
Mean	122.3	126.0	12.4	14.1
± s.d.	16.1	20.8	1.2	1.5

TABLE II-A INDIVIDUAL SCORES FOR EACH CONDITION

SUBJECTS

SUBJECT	RESTRAINT	TASK	BASELINE	-2.00	-1.75	-1.50	-1.25	-1.00	1.00	1.25	1.50	1.75	2.00
1	STD	PRIMARY	152.0	158.3	167.5	183.0	172.3	179.0	163.0	177.8	164.8	162.4	159.0
1	PADS	PRIMARY	167.8	173.0	145.3	186.0	163.5	173.8	173.8	172.3	158.0	155.3	176.3
1	STD	SECONDARY	12.8	14.8	18.0	16.7	24.7	13.9	18.0	18.9	20.9	36.8	24.1
1	PADS	SECONDARY	12.1	17.2	11.8	13.7	10.2	12.2	12.0	15.5	14.3	15.4	18.6
2	STD	PRIMARY	198.8	250.5	261.0	242.5	228.8	232.0	226.3	221.8	226.5	223.0	212.0
2	PADS	PRIMARY	219.4	262.5	311.5	278.0	268.8	234.3	265.5	220.8	215.3	250.5	243.8
2	STD	SECONDARY	9.5	12.8	12.1	10.5	13.0	15.9	9.3	27.6	18.9	17.9	26.1
2	PADS	SECONDARY	14.5	21.2	21.7	24.5	15.5	13.8	18.1	14.6	16.8	16.5	15.5
3	STD	PRIMARY	105.0	173.8	124.5	119.3	106.8	113.0	110.5	118.3	120.0	117.5	151.8
3	PADS	PRIMARY	104.8	121.0	121.5	119.3	117.5	121.5	105.8	123.0	107.3	104.0	110.5
3	STD	SECONDARY	15.9	18.2	13.1	11.2	11.4	11.1	11.5	16.9	16.6	13.7	22.6
3	PADS	SECONDARY	8.5	12.9	16.1	10.7	9.9	9.5	6.6	7.6	11.8	11.6	14.1
4	STD	PRIMARY	123.9	129.8	130.8	127.3	130.0	127.0	121.8	117.0	127.0	134.8	129.0
4	PADS	PRIMARY	125.7	129.8	130.0	117.8	126.3	133.0	130.3	145.0	132.0	132.0	134.5
4	STD	SECONDARY	12.6	10.1	17.3	9.0	11.6	9.9	10.9	8.3	8.4	11.6	9.7
4	PADS	SECONDARY	9.6	13.3	17.6	10.8	8.1	9.2	10.1	10.5	10.3	12.0	11.8
5	STD	PRIMARY	142.4	160.0	151.5	142.0	118.0	150.5	157.5	148.5	174.5	179.5	160.5
5	PADS	PRIMARY	134.7	123.8	118.5	141.5	143.5	132.8	137.8	135.3	143.8	139.8	148.0
5	STD	SECONDARY	18.2	20.8	12.6	19.8	7.5	13.4	8.1	11.6	13.7	36.4	34.3
5	PADS	SECONDARY	6.0	9.6	8.7	7.9	8.6	6.8	7.5	7.7	7.2	6.1	8.5
6	STD	PRIMARY	193.6	211.5	238.3	223.3	208.3	220.8	261.8	258.0	287.0	268.0	276.3
6	PADS	PRIMARY	214.6	218.0	193.0	198.3	214.0	192.5	212.8	205.8	184.5	171.8	201.0
6	STD	SECONDARY	18.4	32.9	33.6	20.1	28.7	16.4	27.2	24.7	27.7	23.3	47.4
6	PADS	SECONDARY	19.5	17.8	16.3	12.4	17.2	14.1	15.2	13.4	16.0	13.1	18.3
7	STD	PRIMARY	131.9	142.4	153.8	154.8	140.8	130.0	135.5	147.3	139.8	150.5	128.0
7	PADS	PRIMARY	131.6	149.3	147.0	164.5	122.0	161.8	145.8	138.0	146.0	145.0	144.0
7	STD	SECONDARY	15.8	16.8	19.0	15.8	10.7	10.8	15.1	20.4	19.9	13.7	20.9
7	PADS	SECONDARY	13.2	13.4	13.0	17.4	12.5	16.7	11.4	13.3	11.9	9.6	14.7

PILOTS

PILOT	RESTRAINT	TASK	BASELINE	-2.00	-1.75	-1.50	-1.25	-1.00	1.00	1.25	1.50	1.75	2.00
1	STD	PRIMARY	130.4	136.5	134.0	144.0	115.5	142.5	154.5	149.0	129.5	146.0	141.0
1	PADS	PRIMARY	132.8	144.5	148.5	146.5	151.0	145.5	153.0	153.5	167.5	159.5	140.5
1	STD	SECONDARY	10.2	15.5	16.5	11.0	12.5	16.0	14.5	16.5	19.0	17.0	22.0
1	PADS	SECONDARY	12.0	13.0	12.0	11.5	12.0	12.0	13.0	12.5	13.5	12.5	11.5
2	STD	PRIMARY	105.8	112.0	135.0	102.0	93.0	99.0	113.5	104.0	109.0	137.5	105.5
2	PADS	PRIMARY	101.6	96.5	93.0	99.5	97.0	100.0	95.5	101.0	91.5	96.0	95.5
2	STD	SECONDARY	13.4	19.5	30.0	18.5	18.0	17.5	16.0	15.5	13.0	25.5	20.5
2	PADS	SECONDARY	13.6	12.0	11.0	11.5	11.5	11.5	11.0	12.0	12.0	12.0	11.5
3	STD	PRIMARY	155.6	130.5	151.0	130.0	141.0	144.0	137.0	152.0	120.0	153.5	154.0
3	PADS	PRIMARY	107.6	100.0	108.0	129.0	111.5	122.5	111.5	105.5	128.0	132.5	121.5
3	STD	SECONDARY	13.8	14.0	15.0	14.0	13.5	13.0	11.0	11.0	10.5	14.0	11.5
3	PADS	SECONDARY	11.6	11.0	11.0	11.5	11.0	10.5	12.0	13.5	14.0	14.0	14.0

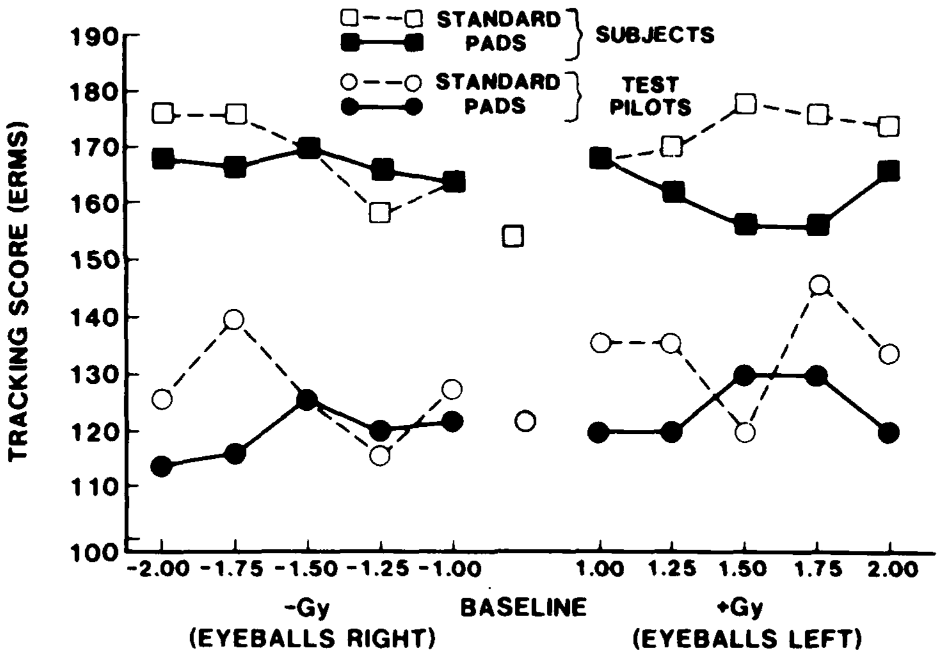


Fig. 1a. Tracking scores for the primary task.

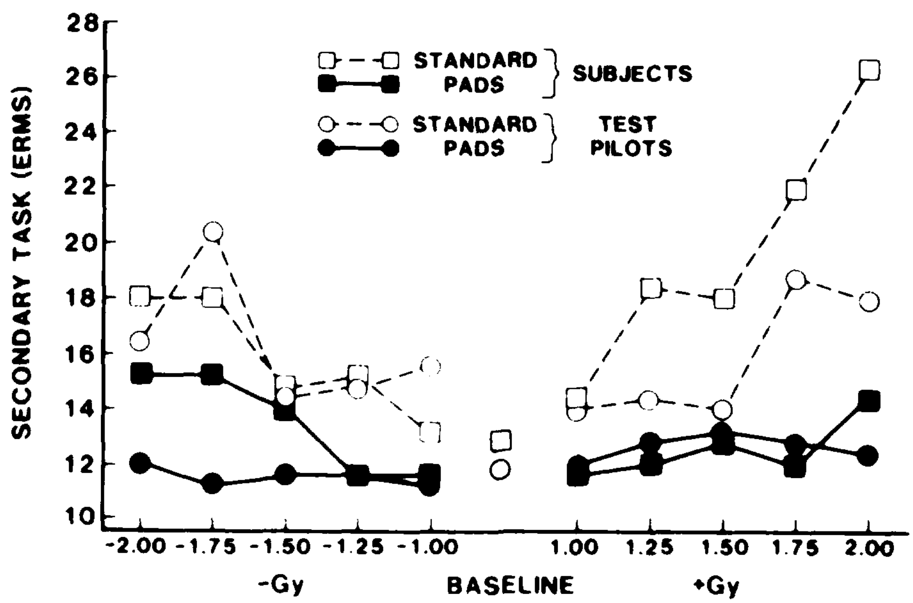


Fig. 2a. Secondary task results.

END
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